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1.	Your reference	RSJ07330GB
2.	Patent application number *(The Patent Office will fill in this)*	0207750.1 04APR02 E708379-6 D02890 P01/7700 0.00-0207750.1
3.	Full name, address and postcode of the or of each applicant *(underline all surnames)*	De La Rue International Limited De La Rue House, Jays Close Viables, Basingstoke Hampshire, RG22 4BS GREAT BRITAIN
	Patents ADP number *(if you know it)*	7563612001
	If the applicant is a corporate body, give the country/state of its incorporation	Great Britain
4.	Title of the invention	OPTICALLY VARIABLE SECURITY DEVICE AND METHOD
5.	Name of your agent *(if you have one)*	Gill Jennings & Every
	"Address for service" in the United Kingdom to which all correspondence should be sent *(including the postcode)*	Broadgate House 7 Eldon Street London EC2M 7LH
	Patents ADP number *(if you know it)*	745002
6.	If you are declaring priority from one or more earlier patent applications, give the country and the date of filing of the or of each of these earlier applications and *(if you know it)* the or each application number	Country / Priority application number *(if you know it)* / Date of filing *(day / month / year)*
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8.	Is a statement of inventorship and of right to grant of a patent required in support of this request? *(Answer 'Yes' if:* *a) any applicant named in part 3 is not an inventor, or* *b) there is an inventor who is not named as an applicant, or* *c) any named applicant is a corporate body.* *See note (d))*	YES

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Request for substantive examination *(Patents Form 10/77)*	
Any other documents *(please specify)*	NO

11. For the applicant
Gill Jennings & Every

I/We request the grant of a patent on the basis of this application.

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OPTICALLY VARIABLE SECURITY DEVICE AND METHOD

The invention relates to a security device and a method of manufacturing such a security device. Such security devices are used for protecting security of documents, tokens of value and other articles.

Traditionally such documents have been used for financial transactions and have taken the form of banknotes, cheques, bonds, travellers cheques and vouchers. More recently secure documents and security devices per se have been used to confer the authenticity of goods and/or services. Security devices have been applied to packaging, labels and certificates accompanying goods such as software, entertainment media, high value consumer goods and fast moving consumer goods.

For both contemporary and traditional applications the essential problem remains the same, to provide a means of authentication that is easy, recognisable by the public and secure against counterfeit. It has been found that the use of optically variable devices is a particularly effective method of meeting these criteria. Moreover it is generally recognised that the broader the range of technologies involved in the creation of a security device the greater its counterfeit resistance. Many Diffractive Optical Variable Identification Device's (DOVID's) intended to function as either thermally activated transfer structures (e.g. hot foils) or as label devices (applied through the application of pressure) require for their fabrication specialised expertise in optical physics, material science, chemistry, embossing, converting and often printing technology.

The use of DOVID's as security devices has become far more prevalent in recent years and consequently the underlying component technologies/sciences have become increasingly accessible to would be counterfeiters. This is particularly the case when an attack is perpetrated by organised crime. In response to this, the holographic

industry has increasingly resorted to including into the DOVID increasingly more complex overt, covert and machine readable features whose reproduction requires very significant capital in specialised machinery and stringent production/fabrication control.

In accordance with a first aspect of the present invention, a security device comprises at least first and second superposed optically variable effect generating structures, each having a surface relief microstructure, the second optically variable effect generating structure being viewable through the first.

In accordance with a second aspect of the present invention, a method of manufacturing a security device comprises providing at least first and second superposed optically variable effect generating structures, each having a surface relief microstructure, whereby the second optically variable effect generating structure is viewable through the first.

We have devised a new type of security device which is readily authenticatable but which is very difficult to counterfeit. This involves providing two (or more) superposed optically variable effect generating structures constructed so as to enable the or each underlying structure to be seen through the overlying structure(s).

Although stacked volume holograms are well known these have been devised in order to achieve multi-colour images since individual volume holograms are typically only sensitive to one colour. However such stacked volume holograms would not appear to be a monolithic structure and would be considerably thicker than the devices envisaged with the present invention and thus unsuitable to act as security devices. They could also be easily tampered with.

The present invention increases the visual sophistication, security and differentiation of the diffractive or holographic imagery present within the DOVID.

Currently within secure OVD manufacture there are the dual pressures of increasingly sophisticated market demands and remaining one step ahead of the counterfeiters using low-end origination technology (e.g. low spec dot-matrix and interferential masking techniques). As a result origination providers have made limited efforts to combine at the primary microstructure mastering stage certain complimentary origination technologies (the most prevalent would be dot matrix imagery overshot onto a classical 3D or 2D/3D hologram) or alternatively to mechanically recombine image components generated using different technologies to build up the final composite image.

The current invention provides a novel device and method for combining into a single filmic assembly, two or more separately originated optically variable microstructures (OVM's), which can be either image generating or machine-readable. Fundamentally the method involves superposing or stacking two or more optically/interferometrically uncoupled microstructure sub-assemblies.

In preferred examples, the uppermost or first OVM sub-assembly defining the first OVM relief (OVM1) is intimately coated with a reflection enhancing layer which could take the form of either:

1) A discontinuous reflective metal coating (provided with substantial de-metallised substantial regions or windows of transparency), or

2) A continuous transparent coating of thickness optimised HRI material (e.g. ZnS, TiO_2).

The lower OVM sub-assembly defines the second OVM relief (OVM2) coated with a reflective opaque layer or metal which may be selectively de-metallised (or is provided with a reflective HRI material).

It should be noted that the desired appearance of the proposed DOVID is one where the DOVID appears to be one complex unitary metallised OVM whose microstructure appears to be generated by the superposition of two separate

origination processes. The origination processes should be chosen such that DOVID does not appear to be composed of two separate microstructure layers simply laminated together.

To date within the holographic industry each of the main origination providers has tended to specialise in one of the limited number of origination technologies that can be used to fabricate image generating optical variable microstructures (OVM's). Examples of such origination techniques include: classical two-step rainbow holography, dot-matrix interferometry, lithographic interferometry and e-beam lithography.

It is preferable that two distinctly different origination technologies, for example e-beam lithography and two-step rainbow holography are used to create OVM 1 and OVM 2.

The device may be applied to a substrate or article to be protected in two distinct ways. Firstly by thermally activated transfer from a carrier foil (e.g. hot-foiling/stamping, roll-on etc) or by application as a label utilising a non-heat activated adhesive. Examples of substrates or articles to which security devices according to the invention may be applied include banknotes, cheques, bonds, travellers cheques, stamps, certificates of authenticity, high value packaging goods and vouchers.

Some examples of devices and methods according to the invention will now be described with reference to the accompanying drawings, in which:-

Figure 1a is a cross-section through a first example of a thermal transfer embodiment prior to completion of the transfer process;

Figure 1b illustrates the example of Figure 1a after transfer;

Figure 2a illustrates a first example of the first OVM shown in Figure 1a;

Figure 2b shows a second example of the first OVM of Figure 1a;

Figure 3 is a schematic cross-section through the second OVM shown in Figure 1a;

Figures 4a and 4b illustrate successive stages in laminating the two OVM structures together;

Figure 5 is a view similar to Figure 4a but illustrating the use of a UV lamp;

Figure 6 is a modified version of the Figure 5 example;

Figure 7 is a schematic cross-section through an example of a label device;

Figure 8 illustrates a device formed by fabricating each layer successively to generate a transfer foil; and

Figure 9 illustrates schematically in cross-section a label device formed by successive provision of layers.

Thermal Transfer Device

We first describe a method for fabricating the layer assembly necessary to allow the device/invention to function as thermal transfer structure (see Figures 1a and 1b).

Production of OVM1 subassembly

Onto a carrier layer 1, typically 16-50 microns PET, a waxy release layer 2 of typically 0.01-0.1 microns thickness is applied followed by a thermoformable lacquer layer 3, typically 1-2 microns thick. The thermoformable layer 3 is then embossed with an optical microstructure 4. The optical microstructure is then coated with a reflection enhancing layer 5. Two types of reflection enhancing layer would be appropriate for this application.

The first option (Figure 2a) is to vacuum coat the microstructure 4 with a transparent high refractive index (HRI) layer of dielectric material (examples being ZnS, TiO_2, ZrO_2 deposited approximately 0.2-0.6 microns thick).

The second option (Figure 2b) is to first vacuum coat the microstructure 4 with an essentially opaque layer of Aluminium 5A, then selectively de-metallise regions 5B of the OVM area, this may be done in register with the microstructure image. Demetallisation is commonly achieved by using print mask and etch approach or by directly printing the etchant.

It should be noted that by using an OPP (oriented polypropylene) carrier 1 an embossing lacquer would not need to be present. The optical microstructure can be embossed directly into the OPP. The rest of the manufacturing process for the OVM1 subassembly remains unchanged.

Production of OVM2 subassembly

A second foil assembly is produced (Figure 3) similar to OVM1 with a carrier 1' and a release layer 2' which is weaker or looser than the release layer 2 of OVM1 (in order to facilitate the combination of the two sub-assemblies). A lacquer layer 3' is provided also. This foil structure is then embossed with a second optically variable microstructure 4' and vacuum coated with an opaque reflective metal coating 5' (typically aluminium 30-60 nanometres thick).

The sub assembly is then coated with an optically clear bonding or laminating layer 6 a few gsm in weight. Suitable materials for the bonding layer 6 are UV curing adhesives such as COATES UV CC E50, and self curing adhesives based upon, for example, acrylic/iso-cyanate curing urethanes.

Laminating two sub-assemblies together

The two sub assemblies OVM1 and OVM2 must now be laminated together. This involves transferring the transferable layers of the OVM2 sub-assembly (i.e. those

layers 3'-6 below the release) onto the back of the OVM1 sub-assembly by passing the two sub assemblies through a pair of laminating nip rollers 20 (Figures 4a,4b) and then peeling off the OVM2 carrier 1'.

In the case where the laminating adhesive 6 is a UV curable composition, the combined foil assemblies can be irradiated just prior to their passing through the nip rollers 20 with UV, the UV source 21 being necessarily on the OVM1 side of the combined assembly (Figure 5). Alternatively the nip roller 20' on the OVM1 side of the laminate could be manufactured of materials transparent to UV light, the UV source 21 being located within its circumference (Figure 6).

Finally the back of the combined assembly is coated with a thermally activated adhesive 9 such as DLRH RK14 (coat weight 1.5 -3gsm) and then rewound: in readiness for slitting and hot stamping.

Note with respect to hot stamping foils, in order to facilitate clean fracture and therefore release it is preferable that the total thickness of the transfer assembly does not exceed 7-8 μmetres. For roll-on stripe applications this could be increased to 10 μmetres.

In use, the structure shown in Figure 1a is brought into contact with a substrate 10 such as a document of value or the like and the adhesive 9 is thermally activated using a hot stamping die or the like. Following activation, the carrier 1 is peeled off as a result of the presence of the wax release layer 2 leaving the device secured to the substrate 10 as shown in Figure 1b.

The construction described above may be further modified to form a label device, the structure of such a device is shown in Figure 7. The structure remains essentially unchanged except that the wax release layer 2 is now absent from the OVM1 sub-assembly and the carrier 1 is transparent. It is also possible that the carrier and

embossing layer may be unified into one material/layer, typically the case when using PVC or OPP.

The manufacture of such a label device will differ from the hot-stamping product at two points. During manufacture of OVM1, the wax release layer 2 will not be present and the embossing lacquer 3 is optional as discussed. Secondly, the heat activated adhesive 9 is replaced with a pressure sensitive adhesive 9'. A suitable pressure sensitive adhesive should be applied at a coat weight of 10-15gsm.

Alternative Method of Manufacture

In an alternative approach the two sub-assemblies are not separately fabricated and subsequently bonded together. Instead the complete assembly is fabricated by the successive application and manipulation of each of the layers resulting in the structure shown in Figure 8 for hot foil applications and Figure 9 for label applications. These will now be described in more detail.

Hot Foils

The OVM1 sub-assembly is manufactured as described above with layers 1 to 5 (Figure 2a). An embossing lacquer 11 is then applied by gravure coating to the back of the reflection enhancing layer 5 (HRI or demet) and it is then embossed with the second optical microstructure 4' (Figure 8). It is preferable that this embossing lacquer 11 has a significantly lower glass transition temperature (T_g) than the lacquer 3 supporting the first optically variable microstructure 4. An alternative approach would be to use a UV curable monomer composition rather than an embossing lacquer. The second optically variable relief could then be cast into the UV curable monomer and cured. Such techniques are described in more detail in US-A-4,758,296. The second optically variable relief 4' is then vacuum

coated with metal such as Aluminium 5' (a typical thickness of aluminium is 30-60nm) and then coated with a thermally activated adhesive 9 (e.g. DLRH RK14). The final product is then re-wound in readiness for application to a substrate 10.

Labels

Two approaches have been identified for the manufacture of labels. The first approach (Figure 9) differs from the heat activated transfer structure only in that the wax release layer 2 is absent from the OVM1 assembly and a pressure sensitive adhesive 9' is used rather than a thermally activated adhesive 9.

As an alternative approach (not shown) an optically clear polymeric film (typically 25-100 microns thick) which if it has suitable thermoplastic characteristics (appropriate glass transition temperature etc) is directly embossed with an optical microstructure into what we shall refer to as its lower surface. Suitable polymers include polypropylene, PVC and less so Polyester due to its high glass transition temperature. Polymers with unsuitable thermoplastic characteristics include polyester or more particularly liquid crystal polymers require the lower surface to be coated with a suitable thermoplastic film or lacquer (1-5 microns thick) prior to embossing.

The lacquer is embossed with the OVMI microstructure and next the microstructure is vacuum metallised with a substantially opaque layer of metal. It is usual to coat a thickness of between 10 and 100 nm especially 30-60 nm. Typically Aluminium, but Copper or any distinctively coloured alloys could be used. The metal layer may then be selectively demetallised if necessary.

The OVM2 subasembly is then laminated onto a Glassine paper coated with between 10 and 20 gsm of pressure sensitive adhesive. Next the upper surface of the OVM2 subassembly is coated with an optically clear laminating

adhesive (the adhesive may be heat, UV or self curing as described previously). Finally the OVM1 subassembly is transferred (from its carrier) onto the upper surface of OVM2 subassembly by passing through a nip whilst activating laminating adhesive through the action of heat or UV light.

Additional Printing or Coating Enhancements

It should be appreciated that the device could be further enhanced by the incorporation of additional materials into or between appropriate layers. All embodiments described within EP-A-497837 are herby included by reference. The various enhancements described within EP-A-497837 could be incorporated between microstructure and reflection enhancing layer in either OVM1 or OVM2..

Further to this dyes or pigments could be incorporated into the laminating adhesive. Such pigments may provide colouration or luminescent effects (phosphorescent and fluorescent). Such materials are well known within the security industry and it is well known to use materials demonstrating either stokes or anti-stoke shifts. Finally other optically variable materials could be used in the laminating adhesive such as photochromics and thermochromics.

As we stated before the current invention creates a laminate structure composed of two or more surfaces/layers of microstructure whose optically variable generating effect appears to derive from one optical effect generating microstructure.

Note OVM1 and OVM2 could each have been generated by a single origination technology such as classical holography. However it is possible that each of the microstructures could have been separately generated using two or more distinct origination technologies and therefore can in themselves can be made very secure. Therefore in principle, by visually integrating the optical variable effects generated by OVM1 and OVM2 in ostensibly a single

microstructure, a device can be created of unique optical appearance, which the counterfeiter and most skilled holographers would regard as prohibitively difficult to reproduce.

In the preferred embodiment OVM1 is intimately coated with a completely transparent high refractive index (HRI) dielectric material 5 (typically ZnS, TiO_2, or ZrO_2 all having a refractive index of approximately 2) with an optical thickness of approximately a quarter wave (i.e. around 100nm for an index of 2) though in contrast to specularly smooth interfaces the thickness of the HRI layer on diffractive relief is not critical. In this preferred embodiment because of the relatively low reflectivity of HRI when compared to a (near opaque film of Aluminium (e.g. at best of the order off a sixth as bright) it is important that OVM1 has intrinsically a high diffractive brightness compared to OVM2, i.e. OVM1 should be composed of pure grating structures such that there is minimal diffusion of the diffracted light and no depth effects. Suitable origination methods to generate OVM1 in this case would be dot-matrix interferometry, lithographic interferometry and e-beam lithography (the latter two would include origination technologies such as the Kinegram® and Exelgram®). OVM2 should preferably generate either a form of iridescence or virtual/apparent depth effect which contrasts and complements the optically variable effect generated by OVM1. Thus OVM2 would preferably be a classical hologram (model, 2D-3D), a Zero-Order diffractive device (ZOD) or a Fresnel structure operating in its very lowest harmonics (a hybrid effect of diffraction and reflection). To balance out their brightness one could further incorporate a colourant or dye into the laminating adhesive to spectrally filter (colour) the replay from OVM2.

A second preferred embodiment is as follows. The uniformly transparent HRI reflection enhancing layer 5 is replaced with a selectively metallised coating of Aluminium

(Figure 2b) and therefore OVM1 need not necessarily be intrinsically very bright . Therefore OVM1 could be provided by origination technologies that generate diffuse diffraction (as for OVM2 in the embodiment above) as well as non-diffuse (as for OVM1 in the embodiment above). Generally it will be especially desirable that the selective metallisation is in register with the image patterns provided by OVM1.

Two such examples would be:

1. OVM1 and OVM2 are complementary ZOD's - for example behind OVM1, the metallisation may be provided in the shape of a De La Rue head on a clear surround. OVM1 may be fabricated to replay a green iridescence when say vertically oriented and Brown when horizontally oriented. Whereas OVM2 may be provided such that it replays Brown when vertically oriented and green when horizontally oriented . Therefore the overall device will have the appearance when vertically oriented of a green Head on brown background and when horizontally oriented, of a brown head on a green background. This simple *swap-over* effect is a powerful authentication feature.

2. The designers of Kinegram®'s and Exelgram®'s and other forms of interferential and non-interferential lithographically generated diffractive optically variable devices, often exploit the fact that from a fabrication viewpoint they can readily alter the orientation (azimuthal angle) of their elemental grating structures by ± 90° to generate orthogonal images. Such that for vertical orientation a first graphical image is diffracted into the observers eye, whilst rotating the device (about an axis normal to its plane) by 90° generates (horizontal orientation) diffracts or relays a second graphical image into the observers eye. This orthogonal image switch is a very powerful feature.

By contrast within a classical two-step rainbow hologram the ability to change the orientation (azimuthal) angle is constrained making the generation of truly orthogonal images difficult. Therefore an important aspect of certain examples of this invention is the design feature that OVM1 and OVM2 contain orthogonal holographic images generated by classical holography. Though of course either or both microstructures may also contain other origination technologies (e.g. dot-matrix overlays).

CLAIMS

1. A security device comprising at least first and second superposed optically variable effect generating structures, each having a surface relief microstructure, the second optically variable effect generating structure being viewable through the first.

2. A device according to claim 1, wherein the first optically variable effect generating structure includes a discontinuous metallic layer.

3. A device according to claim 1, wherein the first optical variable effect generating structure includes a reflective layer formed by a high refractive index dielectric material.

4.. A security device according to claim 3, wherein the first optically variable effect generating structure comprises a substantially pure grating structure in combination with a high refractive index dielectric layer and the second optically variable effect generating structure comprises one of a classical hologram, a zero-order diffractive device, or a Fresnel structure.

5. A device according to any of the preceding claims, wherein the first and second optically variable effect generating structures comprise complementary zero-order diffractive devices.

6. A device according to any of the preceding claims, wherein the first and second optically variable effect generating structures generate orthogonal holographic images, typically originated by classical holography.

7. A device according to any of the preceding claims, wherein the second optically variable effect generating structure includes an opaque, reflective layer.

8. A device according to any of the preceding claims, wherein the first and second optically variable effect generating structures are laminated together.

9. A device according to any of the preceding claims, wherein the first and second surface relief microstructures have been originated by different processes.

10. A device according to any of the preceding claims, wherein the first and second surface relief microstructures have been originated by one of dot matrix interferometry, lithographic interferometry, e-beam lithography and classical rainbow lithography.

11. A device according to any of the preceding claims, further comprising a carrier layer supporting the first and second optically variable effect generating structures.

12. A device according to claim 11, wherein the carrier layer is secured to the first and second optically variable effect generating structures via a release layer.

13. A device according to any of the preceding claims, wherein one or more of the optically variable effect generating structures is formed in a respective lacquer layer.

14. A device according to any of the preceding claims, wherein at least one of the optically variable effect generating structures is formed in a polymer material.

15. A device according to any of the preceding claims, further comprising an adhesive layer to enable the device to be secured to a substrate.

16. A device according to any of the preceding claims, further comprising a dye or pigment providing in or between layer(s) of the optically variable effect generating structures.

17. A device according to any of the preceding claims, further comprising one or more additional optically variable effect generating structures provided between the first and second optically variable effect generating structures.

18. A method of manufacturing a security device, the method comprising providing at least first and second superposed optically variable effect generating structures, each having a surface relief microstructure, whereby the

second optically variable effect generating structure is viewable through the first.

19. A method according to claim 18, wherein each optically variable effect generating structure is formed by embossing a corresponding surface relief microstructure into an embossing layer.

20. A method according to claim 19, wherein the embossing layer comprises an embossing lacquer or polymer.

21. A method according to any of claims 18 to 20, wherein each microstructure is derived from a different origination process.

22. A method according to claim 21, wherein the origination processes are chosen from dot matrix interferometry, lithographic interferometry, e-beam lithography and classical rainbow lithography.

23. A method according to any of claims 18 to 22, further comprising providing the surface relief microstructure of the first optically variable effect generating structure with a partially reflective layer.

24. A method according to claim 23, wherein the partially reflective layer is formed by a high refractive index dielectric material or a discontinuous metallization.

25. A method according to any of claims 18 to 24, wherein the first and second optically variable effect generating structures are fabricated separately and then joined together.

26. A method according to claim 25, wherein the first and second optically variable effect generating structures are laminated together with an intermediate laminating adhesive.

27. A method according to claim 26, wherein the laminating adhesive is UV curable, the securing step including irradiating the laminating adhesive through the first optically variable effect generating structure to activate the adhesive.

28. A method according to any of claims 18 to 27, wherein the first and second optically variable effect generating structures are provided on a carrier.

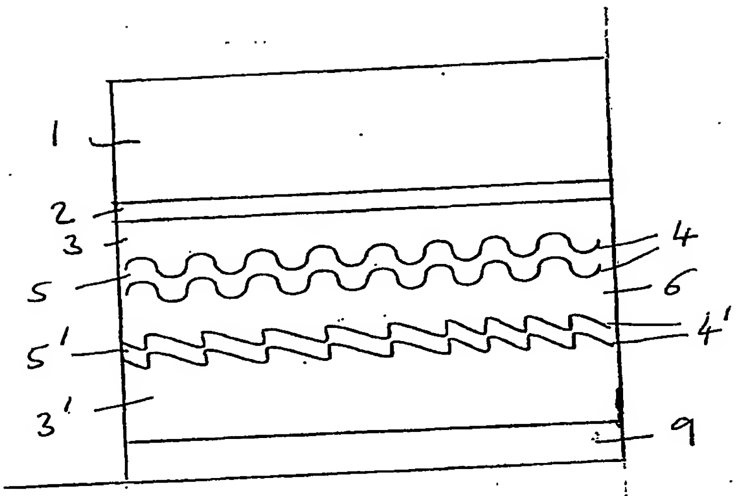
29. A method according to claim 27, wherein a release layer is provided between the carrier and the first and second optically variable effect generating structures.

30. A security device substantially as hereinbefore described with reference to any of the examples shown in the accompanying drawings.

31. A method of manufacturing a security device substantially as hereinbefore described with reference to any of the examples shown in the accompanying drawings.

32. A document of value carrying a security device according to any of claims 1 to 17 or manufactured according to any of claims 18 to 29.

33. A document according to claim 32, the document comprising a document of value such as a banknote.



(10)

FIG 1a

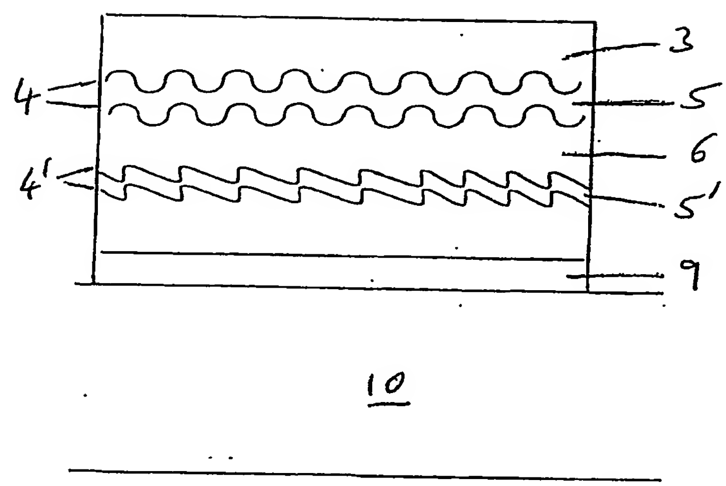


FIG 1b

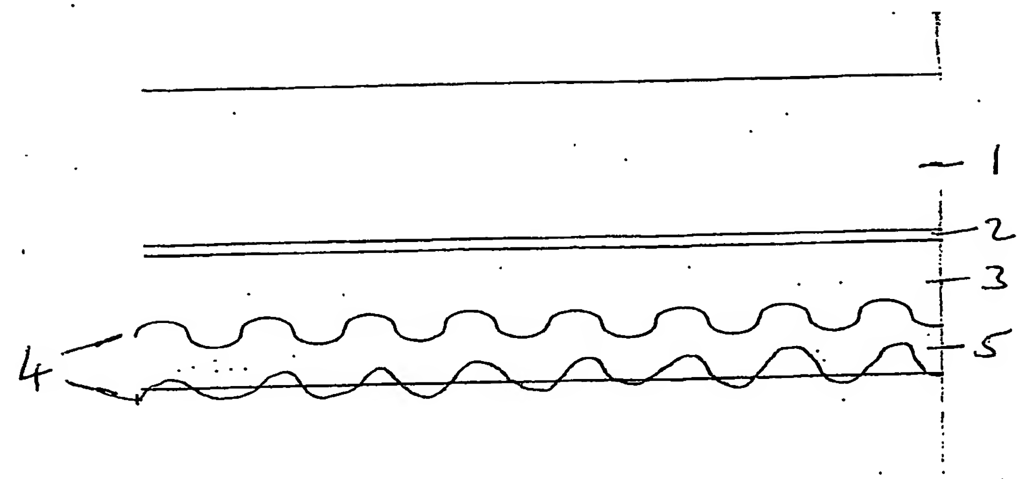


FIG 2a

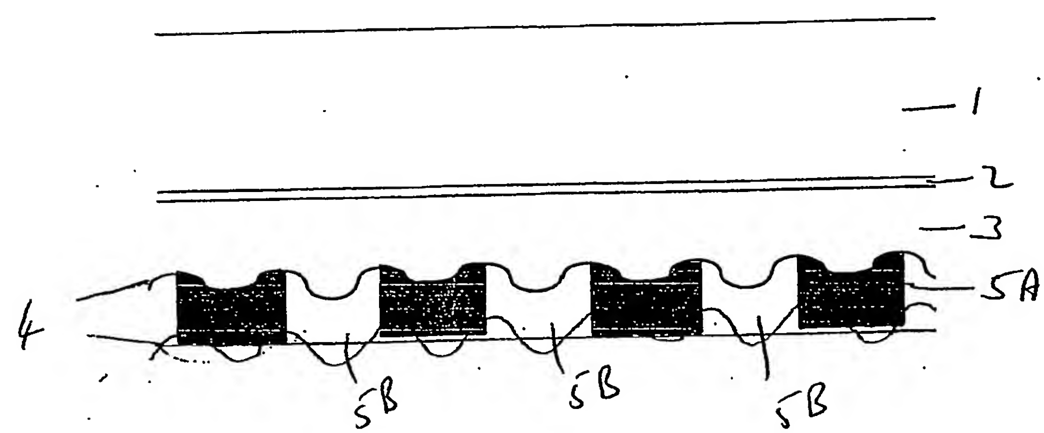


FIG 2b

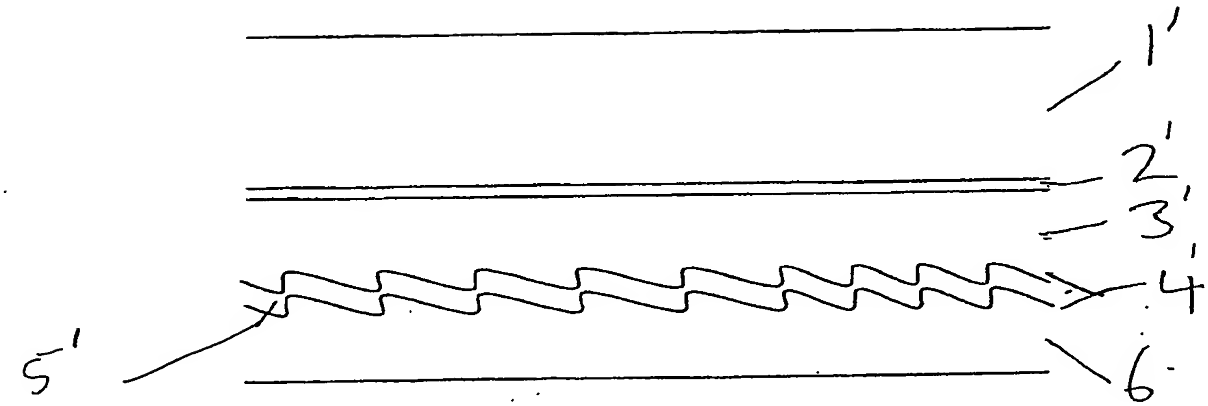


FIG 3

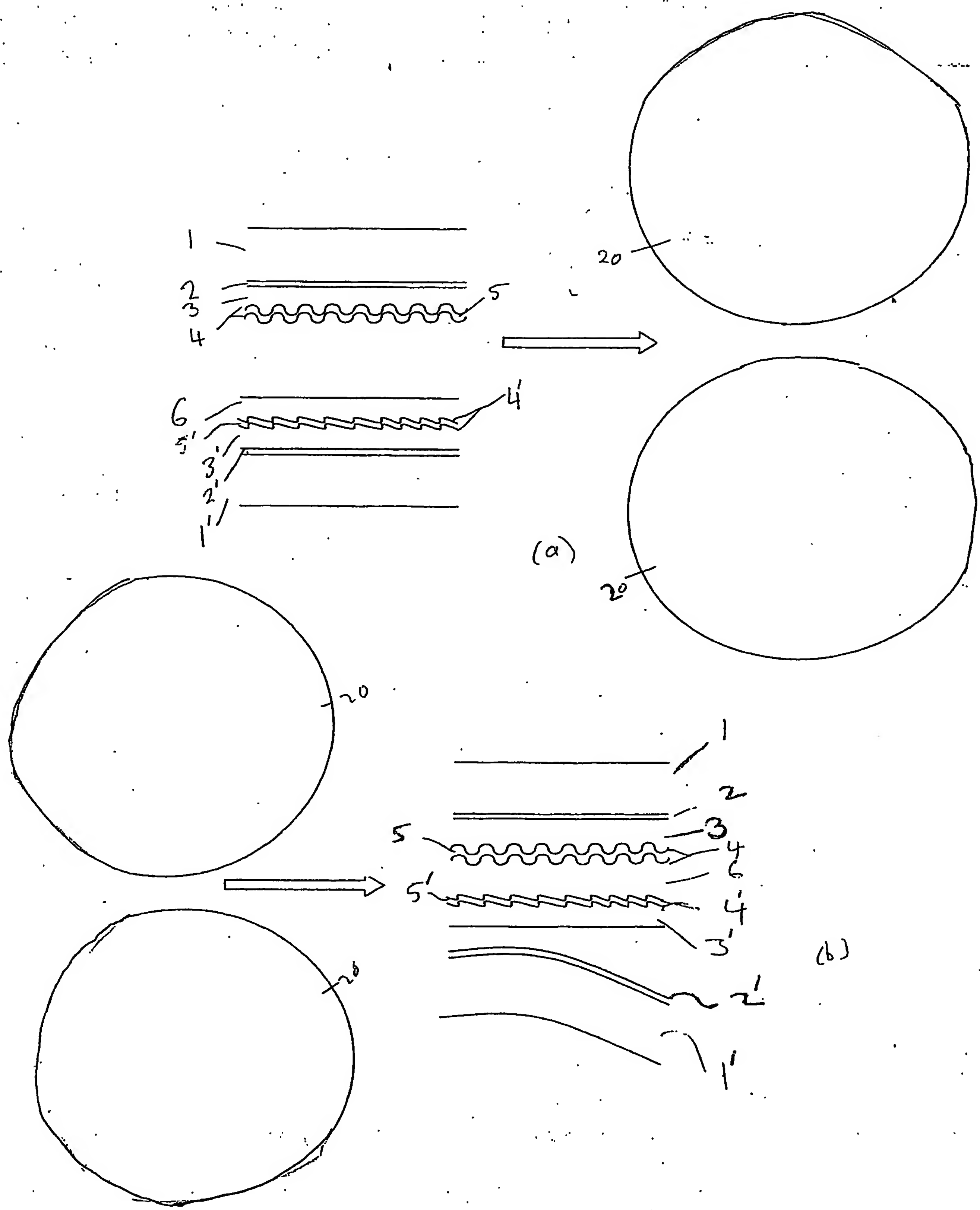


FIG 4

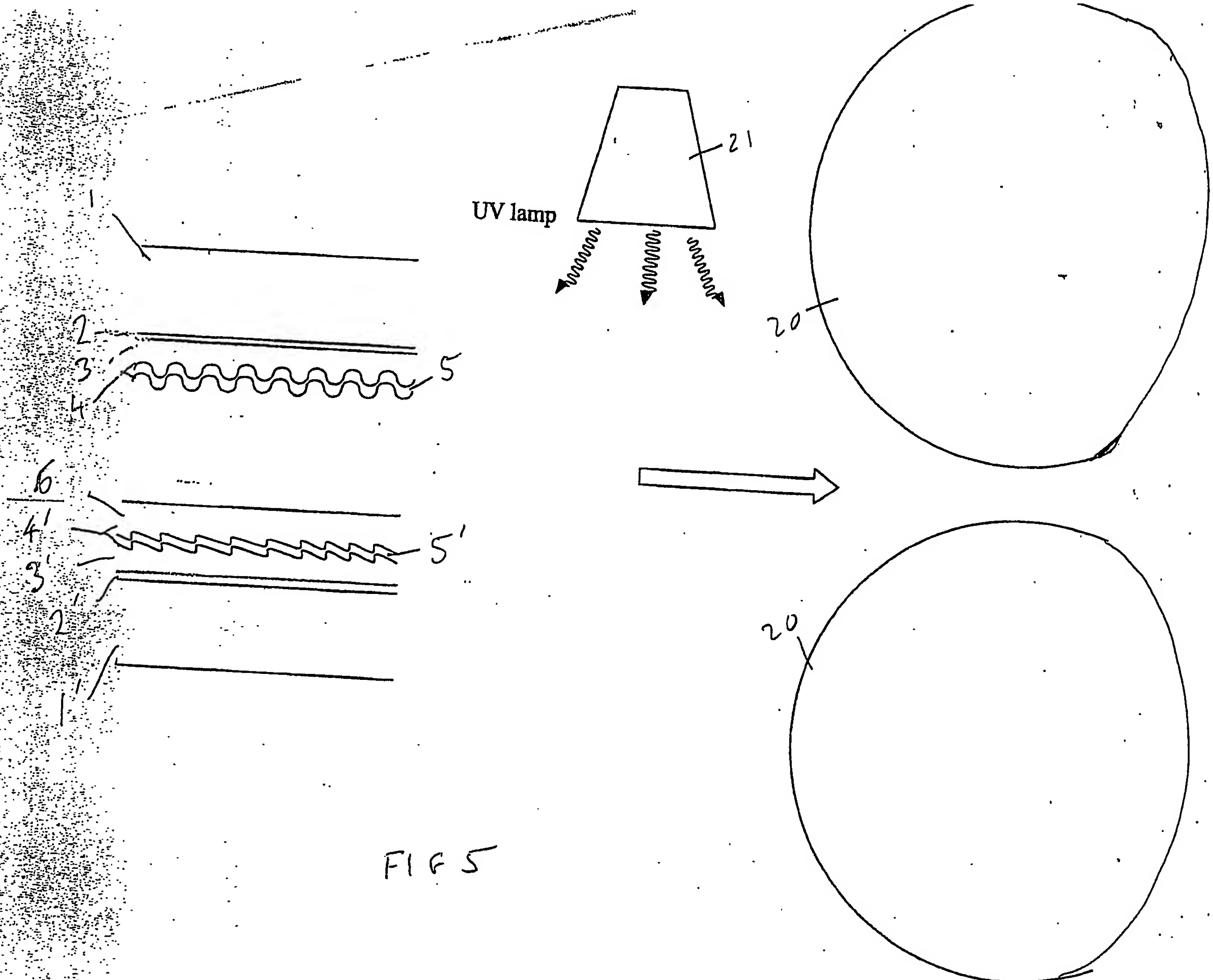


FIG 5

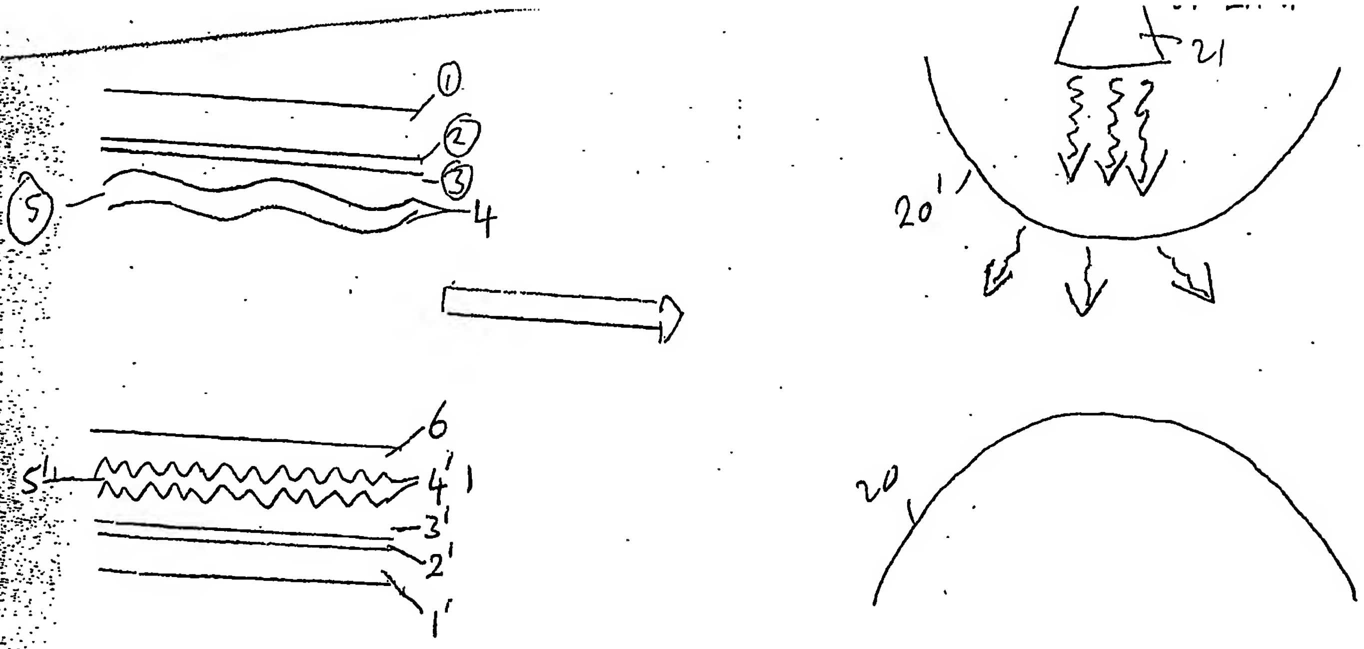


FIG 6

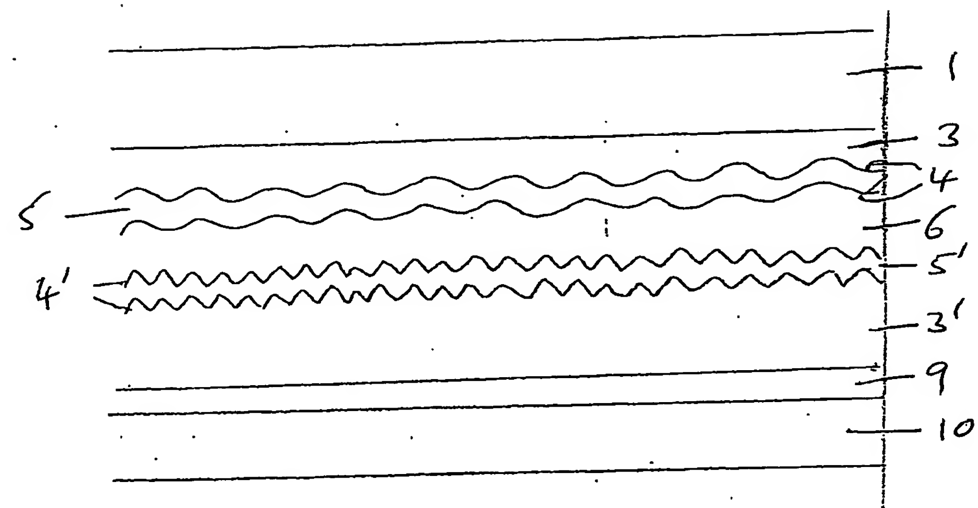


Figure 7

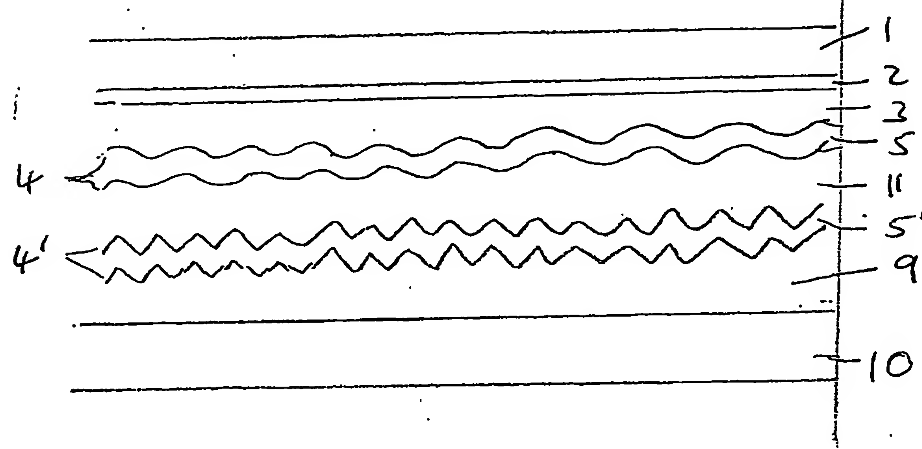


FIG 8

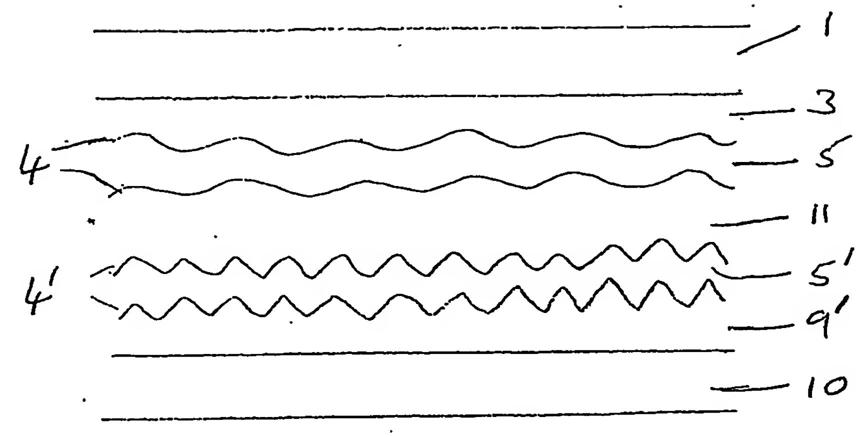


FIG 9